Density and kinematics of the W49A cloud core

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The dense core of the W49A molecular cloud (Miyawaki *et al.* 1986, Schloerb *et al.* 1987) has been mapped in 5 different transitions of CS and $C^{34}S$, in order to determine its density structure. The three lower frequency transitions (CS J=3-2, CS J=5-4 and $C^{34}S$ J=5-4) were observed with the IRAM 30m telescope, and the two highest frequency transitions (CS J=7-6 and $C^{34}S$ J=7-6) with the Caltech Submillimeter Observatory. The beamsizes were in the range $12''$ to $20''$. As a calibration check, the CS J=7-6 line was observed with both telescopes, and was found to give a consistent temperature scale. The spectra at the peak of the emission are shown in Fig. 1.

A map of the dense core in the optically thin $C^{34}S$ J=5-4 line is shown in Fig. 2. The cloud core is seen to extend in a NE-SW direction, and probably consists of two main sub-components displaced from each other in this direction. The brightest emission is well centered in the ring of compact HII regions seen in the radio continuum (Welch *et al.* 1987), and shows a large velocity gradient across its body. A position-velocity plot indicates that the southwestern cloud is likely rotating. Surprisingly, the direction of rotation is *opposite* to that inferred from the compact HII regions. This may be due to optical depth effects in the lower frequency radio recombination lines (Welch, priv. comm).

Statistical equilibrium calculations under the large velocity gradient asumption yield a density of about 7×10^6 cm^{-3} at the center of the cloud, much higher than H_2CO measurements indicate (Dickel and Goss 1990). Assuming a CS abundance of 2.5×10^{-9}, the inferred molecular hydrogen column density is 1.4×10^{24} cm^{-2}. The area and volume filling factors of this dense gas are ~ 0.4 and 0.1, respectively, suggesting that only a few unresolved dense knots are present in our beam. We speculate that these knots would most likely be associated with the compact HII regions seen by Welch *et al.* (1987). The molecular mass in the region is estimated in two ways: both the molecular excitation model and the virial theorem yield a mass of about 10^4 $M_\odot$.

References:

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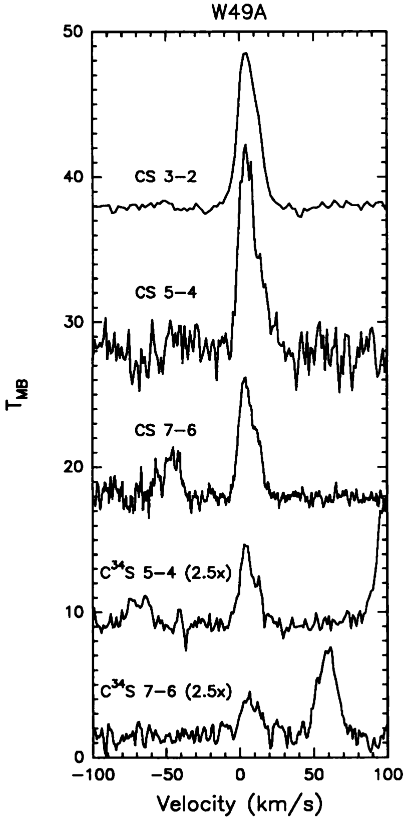

Fig. 1. Spectra of the 5 CS and $C^{34}S$ transitions observed toward (α, δ) = (19:07:50.0, 09:01:20). The lines all appear at an LSR velocity of 4 km s^{-1}.

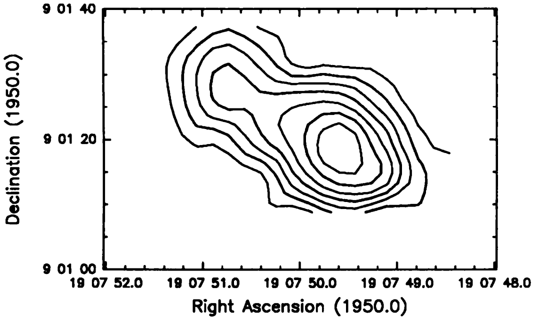

Fig. 2. Integrated intensity contour map of the $C^{34}S$ J=5-4 emission.